

Port Huron, Michigan: on the 4th, at 10.30 p. m., a brilliant aurora was observed with numerous beams flashing up toward the zenith; at 12.15 a. m. the aurora had assumed the shape of two arches, the lower one extending from azimuth 95° to 260°. The display was brightest at 1.10 a. m. of the 5th, after which it gradually faded, but was still visible at 1.45 a. m.

Buffalo, New York: an aurora was visible from 9.20 to 11.15 p. m. of the 23d; it consisted of a diffused white light resting on a broad arch of slate-colored sky. It varied but little in brilliancy and began to fade at 10.30 p. m.

Fort Totten, Dakota: on the 23d an aurora was visible from 9.40 p. m. until midnight; it consisted of a double arch, with beams of light shooting upward from the lower one until 11 p. m.

Auroral displays were also observed during the month, as follows:

2d.—Voluntown, Connecticut; Webster, Dakota; Eastport, Kent's Hill, and Orono, Maine; Amherst, Westborough, and Cambridge, Massachusetts; Nashua, New Hampshire; North Volney, New York; Embarras, Wisconsin.

3d.—Webster, Dakota; Monticello, Iowa; Escanaba, Michigan; Moorhead, Minnesota; Poplar River, Montana; Green Bay, Wisconsin.

4th.—Monticello, Iowa; Vineyard Haven and Amherst, Massachusetts; Escanaba, Michigan; Poplar River, Montana; Nashua, New Hampshire.

5th.—Mackinaw City, Michigan; Poplar River, Montana.

6th.—Fort Buford, Dakota; Pekin, Illinois.

7th.—Ithaca, New York.

14th.—Pekin, Illinois.

15th.—Mackinaw City, Michigan.

18th.—Amherst, Massachusetts.

20th.—Portland, Maine; Milton and North Truro, Massachusetts.

21st.—Yaukon, Dakota.

22d.—Cresco, Iowa; Poplar River, Montana.

23d.—Webster, Dakota; Cedar Rapids, Iowa; Escanaba, Michigan; Poplar River, Montana; Prairie du Chien, Wisconsin.

24th.—Escanaba, Michigan.

25th.—Kent's Hill, Maine; Mackinaw City, Michigan.

27th.—Pekin, Illinois.

29th.—Escanaba and Mackinaw City, Michigan; North Truro, Massachusetts; Nashua, New Hampshire.

30th.—Fort Buford, Dakota; Escanaba and Mackinaw City, Michigan; Moorhead, Minnesota.

ELECTROMETER READINGS.

[Prepared under the direction of Prof. T. C. Mendenhall, Assistant.]

Observations have been made during the month of November, 1886, daily, at 9 a. m., 11 a. m., 1 p. m., and 3 p. m., at five stations, and continuously by means of photography at one station.

At Washington City the observations, compared with those of the preceding month, show a higher general average. At four different times were negative indications obtained. The dates and accompanying conditions of these indications were as follows:

November 6th, in the afternoon, highest value about 100 volts, during light rain; November 12th, from 11.20 a. m. until 12.25 p. m., and from 1.51 p. m., with intervals of positive, until late in the afternoon. The highest negative value, nearly 600 volts, when the weather was rainy. On November 25th, in the afternoon, the highest value, about 450 volts, during heavy rain. On November 30th, in the afternoon, during light rain.

Every instance of negative electricity, as far as the observations go, occurred during rain.

On November 3d and 12th observations were made simultaneously at the top of the Washington Monument and at the Instrument Room of the Signal Office. The observations when plotted give the curves shown in the two diagrams of chart number vi. These experiments are of particular interest for

several reasons. They may be taken as fairly illustrative of the difference in the value of the potential at two different heights, and the effect of the weather in modifying these values. The two days were, as regards weather, exactly opposite. November 3d was a bright, fair day, a trifle hazy, with very light wind and a haze or smoke on the northern and northwestern horizon. The sky was about 0.7 covered with cirro-stratus clouds with hardly any motion. November 12th began with a cloudy, threatening morning, with fresh northeasterly winds, and a prediction, based upon the indications of the electrometer, of coming rain. Rain did not fall at the Monument until 11.30 a. m., although the electrometer gave a zero value at 11.12, and from that time on a steadily increasing negative value, until just preceding the rain, when the indications, although all negative, were very variable. Rain is recorded at the Signal Office as beginning at 11.20 a. m., the electrometer there indicating a positive value at 11.15 and a negative value at 11.20 a. m. At the Monument thick sparks could be obtained, at least as many as thirty per minute. During the afternoon masses of fog would drift by, sometimes below and sometimes enveloping the top of the Monument.

The following abridged record of the observations at the two places shows many interesting features:

Time.	November 3.			November 12.		
	Monument.	Signal Office.	Difference.	Monument.	Signal Office.	Difference.
10.45 a. m.	1250			500	90	410
11 a. m.	1225	282	943	575	132	443
11.05 a. m.	1175	306	869	450	84	366
11.10 a. m.	1200	288	912	125	114	11
11.15 a. m.	1350	258	1092	— 50	24	74
11.20 a. m.	1325	258	1067	— 200	— 6	196
11.25 a. m.	1400	324	1076	— 600	— 102	498
11.30 a. m.	1400	324	1076	— 575	— 90	485
11.35 a. m.	1100	354	746	— 1300	— 288	1012
11.40 a. m.	1125	252	873	— 1650	— 594	1056
11.45 a. m.	1200	264	936	— 500	— 468	32
11.50 a. m.	1200	258	942	— 250	— 480	230
11.55 a. m.	1150	258	892	— 1250	— 480	1120
12 m.	1200	258	942	— 1500	— 378	1122
12.05 p. m.	1325	240	1085	— 1500	— 246	1254
12.10 p. m.	1300	246	1054	— 750	— 276	474
12.15 p. m.	1225	240	985	— 700	— 186	514
12.20 p. m.	1325	222	1091	— 275	— 42	233
12.25 p. m.	1325	294	1031	— 400	— 42	58
12.30 p. m.	1225	300	925	— 600	30	570
12.35 p. m.	1225	300	925	— 625	60	565
12.40 p. m.	1125	300	825	— 250	30	220
12.45 p. m.	1200	270	930	— 225	24	201
12.50 p. m.	1150	282	868	— 75	18	57
12.55 p. m.	1075	240	835	— 350	36	314
1 p. m.	1200	246	954	— 125	6	119
1.01 p. m.	1175	246	829	— 125	6	119
1.02 p. m.	1150	234	916	— 75	0	75
1.03 p. m.	1138	240	898	— 100	0	100
1.04 p. m.	1125	246	879	— 125	6	246
1.05 p. m.	1150	240	910	— 300	18	407
1.06 p. m.	1138	246	892	— 425	24	476
1.07 p. m.	1125	192	933	— 450	24	426
1.08 p. m.	1125	228	897	— 300	24	376
1.09 p. m.	1162	294	868	— 250	18	232
1.10 p. m.	1162	270	892	— 200	12	188
1.11 p. m.	1150	286	864	— 300	12	238
1.12 p. m.	1138	276	862	— 250	18	282
1.13 p. m.	1175	270	905	— 400	24	376
1.14 p. m.	1175	273	902	— 500	30	470
1.15 p. m.	1150	282	868	— 600	30	570
1.16 p. m.	1125	279	846	— 500	30	470
1.17 p. m.	1075	294	781	— 450	18	432
1.18 p. m.	950	270	680	— 400	24	376
1.19 p. m.	925	270	655	— 375	24	351
1.20 p. m.	912	258	654	— 375	18	357
1.21 p. m.	925	252	673	— 375	18	357
1.22 p. m.	950	246	704	— 375	24	351
1.23 p. m.	1000	240	760	— 400	30	370
1.24 p. m.	1025	228	797	— 450	36	414
1.25 p. m.	1050	216	834	— 525	36	489
1.26 p. m.	1025	222	803	— 825	42	783
1.27 p. m.	1012	228	784	— 1050	48	1002
1.28 p. m.	975	246	729	— 1100	66	1034
1.29 p. m.	925	234	691	— 1550	78	1472

Electrometer Readings—Continued.

Time.	November 3.			November 12.		
	Monument.	Signal Office.	Difference.	Monument.	Signal Office.	Difference.
1.30 p. m.	900	216	684	1350	84	1266
1.32 p. m.	888	246	642	1750	72	1678
1.34 p. m.	900	216	684	450	30	420
1.36 p. m.	862	246	616	225	18	207
1.38 p. m.	875	240	635	— 50	12	62
1.40 p. m.	825	222	603	— 50	6	56
1.42 p. m.	862	270	592	— 50	0	50
1.44 p. m.	900	180	720	300	18	282
1.46 p. m.	888	216	672	875	42	833
1.48 p. m.	900	240	660	—	48	—
1.50 p. m.	912	204	708	0	18	18
1.52 p. m.	862	210	652	— 250	— 12	238
1.54 p. m.	850	228	622	— 150	— 6	146
2 p. m.	875	210	665	1000	30	970
2.05 p. m.	775	210	565	1250	12	1238
2.10 p. m.	850	234	616	— 500	— 30	470
2.15 p. m.	875	204	621	— 750	— 54	506
2.20 p. m.	800	210	570	825	6	819
2.25 p. m.	800	246	554	1500	0	1500
2.30 p. m.	750	240	510	875	42	832
2.35 p. m.	750	288	462	— 375	— 30	545
2.40 p. m.	750	288	462	— 750	— 48	702
2.45 p. m.	—	252	—	1000	6	994
2.50 p. m.	700	300	400	— 100	— 54	46
2.55 p. m.	700	228	572	— 200	— 84	16
					— 42	158

The total difference between the values at the two stations for 79 observations, on November 3d, the bright, fair day, is 62,992 volts, or for a difference in altitude of 455 feet, an average difference in the value of the potential equivalent to 797 volts, or nearly 800 volts. For November 12th the sum of the differences in value of the potential at the two stations for 77 observations is 37,231 volts, or an average difference of 483 volts—for the same difference of 455 feet. It may be interesting to compare these values with those given by observations at other times. In the MONTHLY WEATHER REVIEW for October, 1886, are given the values obtained on different dates. The means of those observations are for October 4th, from 48 observations, 398 volts; on October 5th, from 38 observations, 210 volts; on October 7th, from 40 observations, 333 volts.

It will be noticed that the curves for the lower station seem to lag a little, compared with the curves for the upper, regarding any sudden fluctuation in either direction. It is proper to mention that all care was taken to have the observations made synchronously. Of the regular observations, the highest positive values occurred on November 20th, all four observations averaging over 500 volts, the weather being clear with slight haze and light southerly winds. The next highest value occurred on November 5th, at 11 a. m., being almost 500 volts. The highest negative values occur on November 12th, at 11.40 a. m., during heavy rain, and on November 25th, at 3 p. m., during heavy rain.

At Baltimore, Maryland, a continuous record for the month has been obtained. The following is from the observer's report: "The month has been one of rather more than usual electrical disturbance; variations are shown on many sheets, preceding and accompanying rain." There is a very close correspondence in the character of the curves at Washington and those at Baltimore, on November 12th, during the rain previously referred to; the Washington curve, however, seems to lag about 45 minutes behind the curve for Baltimore.

At New Haven, Connecticut, negative indications are recorded on five dates, as follows: November 6th, during rain; November 10th, during light rain; November 12th, during rain, preceded by low positive; on November 17th, at 9 a. m., during light rain, the remaining observations being positive, although the rain continued; November 23d, the highest negative value, 116 volts, in the morning, the observations for the rest of the day being positive, although the rain continued, turning in the afternoon to fog. On November 25th light rain

was accompanied by low positive. On November 25th light rain was accompanied by low positive. On November 18th light rain was accompanied by positive values as low as 0.2 volt. The highest positive values occur on November 2d and November 5th, 77 volts, and on November 27th, 66 volts, during clear weather. On November 12th, that being considered as a term day, we find at New Haven, at 9 a. m., a positive indication, in value 9 volts; at 11 a. m., 11.9 volts; at 1 p. m., 5.3 volts; at 3 p. m., 39.4. Rain began at 1.03 p. m., continuing all day, the next day, November 13th, being cloudy and threatening, the values for this date were 6.2 volts at 9 a. m., 1.3 volts at 11 a. m., 1 volt at 1 p. m., and 2.5 at 3 p. m.

At Boston, Massachusetts, a very complete and valuable set of observations has been made. Rain began November 6th at 11.50 a. m., accompanied with positive values. In this case the electrometer gave no indication of the approach or disturbing effect of rain. On November 10th rain began at 1.30 p. m. At 11 a. m. the values were negative, 75.8 volts; at 1 p. m., 59.2 volts, and at 3 p. m., during the rain, positive, 29.0 volts. On November 13th rain all day was accompanied by low positive values. On November 17th rain was accompanied by high positive values; November 18th threatening weather and rain, accompanied by very high positive values, averaging 345 volts, throughout the day. High positive values continued until the 23d, when rain all day was accompanied by low positive values. On November 25th rain in the morning was accompanied by low positive, and rain in the afternoon by high negative. After the rain very high positive values are recorded. A negative indication occurred on November 15th at 9 a. m., the weather being clear, and no apparent meteorological disturbance in connection with it. The highest positive values obtained during the month were on November 2d in the morning, and November 28–29th.

The observations on November 12th are as follows: At 9 a. m. positive, 129 volts, the weather cloudy; at 11 a. m. positive, 248, the weather fair; at 1 p. m., positive, 160, the weather cloudy; at 3 p. m., positive, 135, the weather cloudy. On November 13th, at 9 a. m., positive, 14 volts, light rain; at 11 a. m., positive, 19, during light rain; at 1 p. m., positive, 37.2, during light rain. Light snow fell during the night and the next morning, clear and bright, the values were about 118 volts, positive.

At Ithaca, New York, a very full and valuable set of observations has been made. Negative values occur on November 6th, during cloudy weather, at 9 a. m., changing to low positive at 11 a. m., and negative, changing to positive, during the afternoon. Light rain began at 12.30 p. m., changing to snow at 1 p. m. During this snow the readings varied, as follows: at 2.59 p. m., negative, 160 volts; at 3 p. m., negative, 121 volts; at 3.01 p. m., negative, 35 volts; at 3.02, positive, 50 volts; at 3.04 p. m., positive, 400 volts; at 3.06, positive, 755 volts; at 3.08 p. m., positive, 855 volts.

On November 11th, low positive at 1 p. m., changing to low negative, with light rain from 1.30 to 2.30 p. m. On November 12th, low positive at 9 a. m., with negative values at 11 a. m. Light snow began at 11.30 p. m.; negative values at 1 p. m., and positive values throughout the rest of the afternoon, during light snow, which continued throughout the next day. Very high positive potentials, about 1,800 volts, were obtained during this snow. On November 14th, after the heavy snowfall of the two days preceding, negative values were obtained during clear weather. On November 15th, at 3 p. m. negative values during clear weather. On November 17th, high negative values throughout the day during light rain. In addition to the date already mentioned snow fell on November 7th and 19th, with positive values. On November 16th the needle was observed to oscillate considerably.

OPTICAL PHENOMENA.

SOLAR HALOS.

Solar halos were observed in the various states and territories during the month, as follows: